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## Original article

## Isolated meniscal injuries in paediatric patients: Outcomes after arthroscopic repair



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## ABSTRACT

**Background:** The management of isolated meniscal tears in paediatric patients is poorly standardised, and few published data are available. Nevertheless, there is widespread agreement that meniscectomy, even when partial, produces poor outcomes including the premature development of osteoarthritis.

**Hypothesis:** Arthroscopic repair of isolated meniscal tears in paediatric patients yields good outcomes and should be attempted routinely.

**Materials and methods:** We retrospectively assessed 19 arthroscopic repair procedures performed between 2006 and 2010 by a single surgeon in 17 patients with a mean age of 14 years. In every case, the knee was stable and the meniscus normal before the meniscal tear, which was the only injury. Mean follow-up was 22 months. In all 19 cases, the evaluation included a physical examination, pre-operative magnetic resonance imaging (MRI), and determination of the Tegner and Lysholm scores. Post-operative MRI was performed in 10 cases.

**Results:** The outcome was good in 12/17 (70%) patients with significant improvements in the mean Tegner score, from 3.9 to 7.1, and mean Lysholm score, from 55.9 to 85.4, between the pre-operative and post-operative assessments. The clinical outcomes were not significantly associated with time to arthroscopic repair, gender, lesion site, or lesion type. Neither was any correlation demonstrated between clinical outcomes and meniscal healing as assessed by MRI.

**Discussion:** The known poor outcomes after meniscectomy in paediatric patients, the results of our study, and previously published data support routine arthroscopic repair of isolated meniscal tears in this age group, regardless of the site and type of injury. In addition, in asymptomatic patients, clinical follow-up is sufficient and post-operative MRI unnecessary.

**Level of evidence:** Level IV. Retrospective study.

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## 1. Introduction

Isolated meniscal tears are uncommon in paediatric patients yet constitute a well-recognised entity [1]. The menisci play an indispensable role in ensuring normal knee function [2]. Available treatment options include total or partial meniscectomy and repair of the meniscal tear. Sound evidence exists that total or partial meniscectomy is a highly deleterious procedure in paediatric patients that induces the development of premature osteoarthritis [3,4]. Few data are available on isolated meniscal tears, which are far less common than combined meniscal and ligamentous injuries [5]. Nevertheless, isolated traumatic meniscal tears are more common

in the paediatric population than in adults [6]. Studies in adults who underwent repair of isolated meniscal tears in stable knees showed success rates ranging from 33% to 76% [7–9]. We are aware of a single study that specifically addressed outcomes after arthroscopic repair of isolated meniscal tears in paediatric patients [10].

Here, our objectives were to evaluate whether arthroscopic repair of isolated meniscal tears in paediatric patients produced good outcomes and to identify factors associated with post-repair outcomes.

## 2. Material and methods

We retrospectively reviewed the outcomes after arthroscopic repair of isolated meniscal tears in stable knees performed at the paediatric surgery department of the Toulouse University Hospital, Toulouse, France, between 2006 and 2010. The same surgeon

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**Table 1**  
Characteristics of the meniscal tears and repair techniques.

Case	Age/gender	Type of lesion	Lesion site	Zone	Repair technique/material	Time to repair, months
1	11/F	Horizontal	Posterior horn Medial	White/red	Abrasion and perforations	12
2	15/M	Longitudinal	Anterior horn Lateral	White/red	Trimming All-inside Fast-Fix™	6
3	14/F	Radial	Posterior horn Medial	White/red	Outside-in Fiberwire	2
3bis		Complex	Middle segment Medial	Red/red	All-inside Fast-Fix™	2
5	16/F	Complex	Posterior horn Medial	Red/red	All-inside RapidLock	6
5bis		Longitudinal	Posterior horn and lateral Body	White/red	All-inside RapidLock	6
7	10/M	Longitudinal	Posterior horn Lateral	White/red	All-inside RapidLock	2
8	9/M	Bucket handle	Posterior horn and medial body	White/red	All-inside Fast-Fix™ and RapidLock	1
9	16/M	Bucket handle	Posterior horn and medial body	White/red	All-inside RapidLock	0.75
10	12/M	Bucket handle	Posterior horn and lateral body	White/red	All-inside RapidLock	1
11	13/F	Longitudinal	Posterior horn Lateral	White/red	All-inside RapidLock	5
12	14/M	Complex	Posterior horn and lateral body	White/red	Trimming All-inside RapidLock	10
13	14/F	Longitudinal	Posterior horn and medial body	Red/red	All-inside RapidLock	4
14	11/M	Bucket handle	Posterior horn and lateral body	White/red	All-inside Fast-Fix™	5
15	16/M	Horizontal	Posterior horn and medial body	White/red	Trimming All-inside Fast-Fix™	6
16	18/F	Longitudinal	Posterior horn Lateral	White/red	All-inside RapidLock	3
17	16/M	Radial	Anterior horn and lateral body	White/red	Trimming All-inside RapidLock	11
18	14/F	Horizontal	Posterior horn Medial	White/red	Trimming All-inside RapidLock	12
19	15/F	Longitudinal	Medial body	White/red	All-inside RapidLock	6

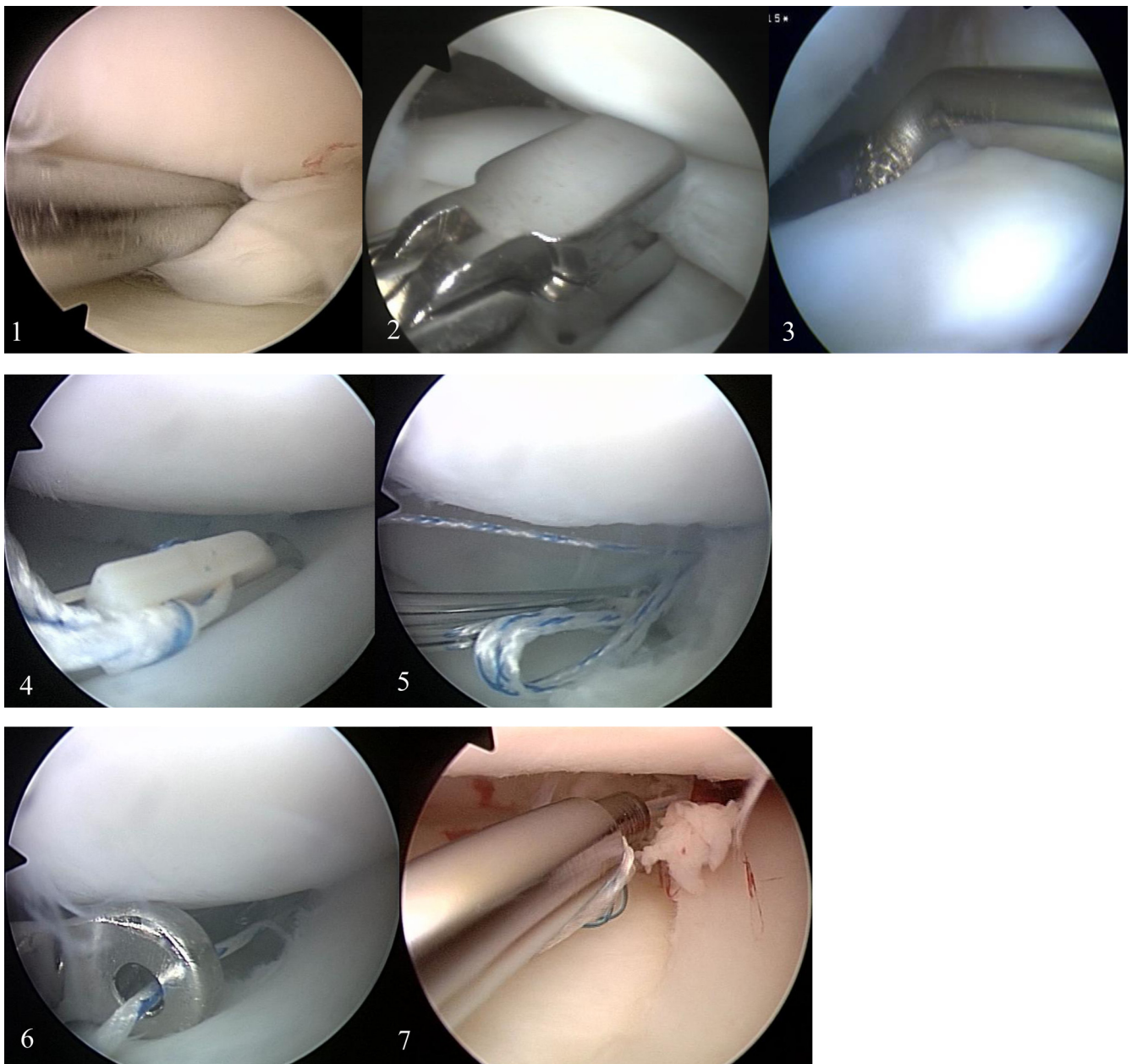
performed all procedures. We identified 19 arthroscopic repair procedures in 17 patients, including 9 boys and 8 girls. The left knee was involved in 10 cases and the right knee in 9 cases. Mean age was 14 years (range, 9–18 years) and mean follow-up was 22.3 months (range, 3.5–46 months). We confined our study to patients who had one or more meniscal tears with a stable knee and no degenerative meniscal alterations. Of the 17 patients, 3 had a past history of anterior cruciate ligament (ACL) repair (by ligament reconstruction using gracilis and semi-tendinosus tendons), during which no meniscal injuries were identified by arthroscopy; the knee was considered stable in all 3 patients, based on a physical examination and magnetic resonance imaging (MRI). We excluded patients with knee instability or a discoid meniscus.

All patients had a history of trauma to the affected knee. Mean time from trauma to arthroscopic repair was 5.3 months (range, 3 weeks–1 year). Pre-operatively, all patients underwent a physical examination and MRI to assess the location and type of the meniscal injury [11]. Symptoms were consistently present at the initial evaluation; they included pain ( $n = 12$ ), at least one episode

of acute locking of the knee, pseudo-locking of the knee ( $n = 1$ ), and recurrent knee effusions ( $n = 2$ ). By MRI, the 19 meniscal injuries were distributed as follows: longitudinal tears,  $n = 7$  (including 4 with unstable flaps); radial tears,  $n = 2$ ; horizontal cleavage tears,  $n = 3$ ; complex tears,  $n = 3$ ; and grade 3 bucket-handle tears,  $n = 4$  [11]. The posterior segment was involved in 12 cases, the middle segment in 6 cases, and the anterior segment in 2 cases; there were also 4 bucket-handle tears. The medial meniscus was torn in 10 cases and the lateral meniscus in 9 cases. Of the 19 tears, 16 involved both the white and the red zones and 3 only the red zone (Table 1).

The same arthroscopic repair technique was used in all 19 cases. The patient was supine with a lateral support at the thigh. A tourniquet was placed at the root of the thigh. A 4-mm 30° arthroscope was used, as well as a shaver, a meniscal rasp, graspers, and a basket forceps.

Of the 19 tears, 18 were repaired by suturing (Table 1); the outside-in technique with fiberwire was used in 1 case and the all-inside technique with Fast-Fix™ (Smith & Nephew, London, UK) and/or RapidLock (DePuy Mitek, Raynham, MA, USA) in 17 cases.



**Fig. 1.** Meniscal suturing using the Fast-Fix™ system. 1. Identification of the tear using a palpator. 2. Minimal trimming (not performed routinely). 3. Abrasion using the rasp. 4 and 5. Suturing using two passages of the delivery needle to implant the two anchors into the meniscal wall. 6. Tightening of the knot. 7. Section of the traction suture.

Stitches were placed at 5-mm intervals all along the tear after abrasion using a shaver or rasp (Fig. 1). The remaining tear was managed by abrasion only, without suturing. In 5 cases, the meniscus was trimmed before being sutured.

The post-operative programme included immobilisation for 4 weeks to preclude excessive pivoting and flexion of the knee that might impair meniscal healing. Then, rehabilitation was started by passive mobilisation from 0° to 100° and closed kinetic chain exercises to strengthen the quadriceps. Bicycling was allowed after 3 months and pivot and contact sports after 6 months.

Healing of the repaired meniscal tear was evaluated in 10 cases by post-operative MRI. Mean time from repair to MRI was 19.2 months (range, 8–31 months). In the remaining cases, the patients declined follow-up MRI.

For each case, outcomes were evaluated based on the Tegner activity level scale and Lysholm score [12,13]. The values obtained before and after arthroscopic repair were compared using the

Wilcoxon signed-rank test for paired samples. Values of  $P < 0.05$  were considered statistically significant. We used the Lysholm score to separate the cases into three categories: 84–100, excellent or good outcome; 65–83, fair outcome; and 0–65, poor outcome.

Fisher's exact test was chosen to evaluate potential associations between clinical outcomes and the following variables: gender, meniscus involved, type of tear, time to arthroscopic repair, and whether partial meniscectomy was performed in addition to tear suturing. Values of  $P < 0.05$  were considered significant. We used the same strategy to look for associations between clinical outcomes and MRI evidence of healing.

### 3. Results

Clinical improvements were documented, with significant differences between the pre-operative Tegner and Lysholm score values and those obtained at last follow-up ( $P = 0.0003$ ) (Table 2).

**Table 2**  
Improvements in the Tegner score ( $P=0.0003$ ) and Lysholm score ( $P=0.0003$ ).

	Tegner before repair	Tegner at last follow-up	Lysholm before repair	Lysholm at last follow-up
1	5	7	52	95
2	4	5	56	64
3	4	6	51	85
4	4	6	48	80
5	4	5	60	64
6	3	8	56	99
7	3	8	49	95
8	5	9	70	100
9	4	7	70	94
10	5	9	57	84
11	3	7	48	85
12	3	6	43	75
13	4	7	61	84
14	3	6	48	80
15	5	8	61	84
16	4	9	56	99
17	4	8	64	85

**Table 3**  
Clinical outcomes according to time from injury to surgery ( $P=0.62$ ).

	0–3 months	4–6 months	7–12 months	Total
Good or excellent	5	4	4	13
Fair	1	3	0	4
Poor	1	1	0	2
Total	7	8	4	19

**Table 4**  
Clinical outcomes according to gender ( $P=0.32$ ).

	Male	Female	Total
Good or excellent	6	7	13
Fair	1	3	4
Poor	2	0	2
Total	9	10	19

**Table 5**  
Clinical outcomes according to the meniscus involved ( $P=0.118$ ).

	Medial	Lateral	Total
Good or excellent	9	4	13
Fair	1	3	4
Poor	0	2	2
Total	10	9	19

The mean Tegner score improved from 3.9 (range 3–5) to 7.1 (range, 5–9) and the mean Lysholm score from 55.9 (range, 43–70) to 85.4 (range, 64–100).

Based on the Lysholm score, the outcome was good or excellent in 12 (70%) patients, fair in 3 (18%) patients, and poor in 2 (12%) patients due to a repeat sports-related injury with recurrence of the tear.

Mean time to arthroscopic repair was 5.3 months. This variable was not significantly associated with the clinical outcomes ( $P=0.62$ ) (Table 3). Outcomes were similar in boys and girls ( $P=0.32$ ) (Table 4). Neither did outcomes differ significantly between tears in the medial versus the lateral meniscus ( $P=0.12$ ) (Table 5). Finally, the outcomes were not significantly influenced

**Table 6**  
Clinical outcomes according to the type of tear ( $P=0.87$ ).

	Longitudinal	Radial	Horizontal	Complex	Bucket handle	Total
Good or excellent	3	2	3	2	3	13
Fair	2	0	0	1	1	4
Poor	2	0	0	0	0	2
Total	7	2	3	3	4	19

**Table 7**  
Clinical outcomes according to whether meniscal trimming was performed ( $P=0.41$ ).

	Suture + partial resection	Suture only	Total
Good or excellent	4	8	12
Fair	0	4	4
Poor	1	1	2
Total	5	13	18

by the type of lesion ( $P=0.87$ ) (Table 6) or concomitant partial meniscal resection ( $P=0.41$ ) (Table 7).

Of the post-operative MRI scans, 5 were normal, 3 showed a persistent grade 3 tear, 1 a persistent grade 2 tear, and 1 a persistent grade 1 tear (Table 8). Clinical outcomes were not significantly associated with healing of the tear as assessed by MRI ( $P=0.71$ ) (Table 9).

#### 4. Discussion

We evaluated outcomes after arthroscopic repair of isolated meniscal tears in stable knees in patients younger than 18 years. Good or excellent outcomes were achieved in 70% of patients. We did not identify any factors significantly associated with the outcome.

Our retrospective study has several limitations. The number of patients was small, and we had no control group. We were unable to assess potential associations between clinical outcomes and tear location, as 17 of the 19 tears were in the white/red zone. Finally, post-operative MRI was performed in only 10 cases. However, MRI findings may be of limited relevance, as successfully treated lesions may continue to generate grade 3 high-intensity signal long after healing of the meniscus is achieved [14]. Thus, in a study by Accadbled et al. [15], MRI findings suggested treatment failure in 66% of cases, whereas the clinical outcomes were good in 75% of cases.

The incidence of meniscal tears in paediatric patients remains unknown. However Stanitski et al. [16] reported that meniscal tears were present in 47% of paediatric patients who had knee injuries with haemarthrosis. In a paediatric study of outcomes after meniscectomy for isolated meniscal tears, Manzione et al. [3] found that only 25% of patients were asymptomatic after 5 years and that 80% had radiographic evidence of osteoarthritis.

Studies in paediatric patients have shown favourable outcomes after arthroscopic meniscal repair in 66% to 100% of patients. However, weaknesses of these studies include patient heterogeneity (meniscal tear plus ACL injury) and short follow-up duration [17–19].

We are aware of a single published study by Krych et al. [10], focussing specifically on the arthroscopic repair of isolated meniscal tears in paediatric patients. There were 45 tears in 44 patients, and follow-up was 2 years. Clinical outcomes were favourable in 62% of cases. The technique used to repair the meniscal tear was not significantly associated with the outcome. In our study, the same technique was used in 15 cases and, therefore, our data cannot provide information about whether one technique is superior over another. The distance from the tear to the periphery of the meniscus significantly influenced the outcome: thus, a rim width greater than 3 mm was significantly associated with treatment failure.



**Table 8**Clinical outcomes according to healing as assessed by magnetic resonance imaging ( $P=0.57$ ).

	Normal MRI	Grade 3 lesion	Grade 2 lesion	Grade 1 lesion	Total
Good or excellent	3	1	1	1	6
Fair	2	0	0	0	2
Poor	0	2	0	0	2
Total	5	3	1	1	10

**Table 9**Healing as assessed by magnetic resonance imaging according to type of tear ( $P=0.91$ ).

	Normal MRI	Grade 3 lesion	Grade 2 lesion	Grade 1 lesion	Total
Longitudinal	1	2	0	1	4
Radial	1	0	1	0	2
Horizontal	1	0	0	0	1
Bucket handle	2	1	0	0	3
Total	6	3	1	1	10

Other studies, in contrast, showed good outcomes after the repair of tears located in the avascular zone. Thus, of the patients studied by Vanderhave et al. [18], 9 were classified as fully recovered 2 years after suturing of tears in avascular zones. Rubman et al. [20] evaluated outcomes of 198 tears in the avascular zone and found that 80% of patients were symptom-free after 2 years. We were unable to assess this factor, as 16 of the 19 tears were in the same zone. The available data support arthroscopic repair of meniscal tears in the avascular zone, particularly as the blood supply to the menisci is more abundant in children than in adults [21]. Finally, Krych et al. [10] demonstrated that complex tears were significantly associated with poor outcomes. Similarly, among adult athletes, those with complex meniscal tears had poorer outcomes compared to those with simple tears [20,22]. In our study, the clinical outcomes were not significantly associated with the type of meniscal tear.

Meniscal tears are often diagnosed late, after more than 12 months [17]. Although a longer time from injury to repair is usually believed to predict poorer outcomes [7,9], several studies found no significant impact of this factor in the absence of major structural alterations of the meniscus [9,10,18,23], in keeping with our findings.

Several authors advocate repairing all lesions, of any type, provided they are reducible and the repair is stable [19,22].

## 5. Conclusion

To the best of our knowledge, the work reported here is the second study focussing on isolated meniscal tears in paediatric patients without knee instability. Our data support routine arthroscopic repair of these meniscal tears, regardless of their type and location. In addition, clinical follow-up may suffice in asymptomatic patients, in whom post-operative MRI seems unnecessary. Although studies with longer follow-ups and larger cohorts are needed, our results support routine arthroscopic repair of isolated meniscal tears in paediatric patients without knee instability.

## Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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